CLAIMS

1. A flowmeter, comprising: transmission/reception means provided in a flow path for performing transmission/reception using a state change of fluid; repetition means for repeating signal propagation with the transmission/reception means; time measurement means for measuring a propagation time of a state change during repetition by the repetition means; flow rate detection means for detecting a flow rate based on a value of the time measurement means; and number-of-times change means for changing to a predetermined number of repetition times.

2. A flowmeter according to claim 1, comprising a pair of transmission/reception means which utilize propagation of an ultrasonic wave as the state change of fluid.

3. A flowmeter according to claim 1, comprising transmission/reception means which utilizes propagation of heat as the state change of fluid.

4. A flowmeter according to any of claims 1-3, comprising elapsed time detection means for detecting halfway information for a time of propagation repeated by the repetition means; frequency detection means for detecting a frequency of a flow rate variation from information of the elapsed time detection means; and number-of-times change means for setting a measurement time so as to be substantially a multiple of the frequency detected by the frequency detection means.

5. A flowmeter according to claim 4, comprising data holding means for holding at least one or more propagation time of

transmission/reception which is obtained by the elapsed time detection means; and frequency detection means for detecting a frequency by comparing the data held by the data holding means and measured propagation time data.

6. A flowmeter according to any of claims 1-5, wherein the number-of-times change means is operated in predetermined processing.

7. A flowmeter according to claim 6, wherein the number-of-times change means is operated at each predetermined flow rate measurement.

8. A flowmeter according to claim 6, wherein the number-of-times change means is performed before flow rate measurement processing.

9. A flowmeter according to claim 6, wherein predetermined processing includes operations of abnormality determination means for determining abnormality in flow rate from flow rate measurement; and flow rate management means for managing a use state for a flow rate from a measured flow rate.

10. A flowmeter according to any of claims 4-9, wherein the number of repetition times which is adjusted to the frequency obtained by the frequency detection means is used in next flow rate measurement.

11. A flowmeter according to any of claims 1-5, wherein the number-of-times change means is operated when the measured flow rate is lower than a predetermined flow rate.

12. A flowmeter, comprising: transmission/reception means provided in a flow path for performing transmission/reception using a state change of fluid; time measurement means for measuring a propagation time of a state change transmitted/received by the transmission/reception means; flow rate detection means for detecting a flow rate based on a value of the time measurement means; variation detection means for measuring a variation in the flow path by the transmission/reception means; and measurement control means for starting measurement in synchronization with a timing of a variation of the variation detection means.

13. A flowmeter according to claim 12, comprising a pair of transmission/reception means which utilize propagation of an ultrasonic wave as the state change of fluid.

14. A flowmeter according to claim 12, comprising transmission/reception means which utilizes propagation of heat as the state change of fluid.

15. A flowmeter according to claim 13, comprising: first vibration means and second vibration means provided in a flow path for transmitting/receiving an sonic wave; switching means for switching an transmission/reception operation of the first vibration means and the second vibration means; variation detection means for detecting a pressure variation in a flow path at at least one of the first vibration means and the second vibration means; time measurement means for measuring a propagation time of a sonic wave transmitted/received by the first vibration means and the second vibration means; measurement control means for performing synchronous control where, when an output of the

variation detection means shows a predetermined change, the measurement means measures a first measurement time T1 of propagation from the first vibration means at an upstream side in the flow path to the second vibration means at a downstream side in the flow path, and when the output of the variation detection means shows a change opposite to the predetermined change, the measurement means measures a second measurement time T2 of propagation from the second vibration means at a downstream side in the flow path to the first vibration means at an upstream side in the flow path; flow rate detection means for calculating a flow rate using the first measurement time T1 and the second measurement time T2.

16. A flowmeter according to claim 15, comprising: measurement control means for performing measurement control where measurement of the first measurement time T1 is started when an output of the variation detection means shows a predetermined change and measurement of the second measurement time T2 is started when the output of the variation detection means shows a change opposite to the predetermined change, and measurement control where, in a next measurement, measurement of the first measurement time T1 is started when the output of the variation detection means shows a change opposite to the predetermined change and measurement of the second measurement time T2 is started when the output of the variation detection means shows the predetermined change; and flow rate calculation means for calculating the flow rate by successively averaging a first flow rate obtained by using the previous first measurement time T1 and previous second measurement time T2 while alternately changing start of measurement and a second flow rate obtained by using next first measurement time T1 and

next second measurement time T2.

17. A flowmeter according to any one of claims 12-16, comprising repetition means for performing transmission/reception a plurality of times.

18. A flowmeter according to claim 17, comprising repetition means for performing transmission/reception a plurality of times over a time period which is a multiple of a variation cycle.

19. A flowmeter according to claim 18, comprising repetition means for starting transmission/reception measurement when an output of the variation detection means shows a predetermined change and repeating the transmission/reception measurement until the output of the variation detection means shows the same change as the predetermined change.

20. A flowmeter according to any one of claims 12 and 15-19, comprising selection means for switching a case where the first vibration means and second vibration means are used for transmission/reception of a sonic wave and a case where the first vibration means and second vibration means are used for detection of a pressure variation.

21. A flowmeter according to any one of claims 15-20, comprising variation detection means for detecting a component of an alternating component of a variation waveform which is in the vicinity of zero.

22. A flowmeter according to any one of claims 15-21, comprising: frequency detection means for detecting the

frequency of a signal of the variation detection means; and measurement control means for starting measurement only when the frequency detected by the frequency detection means is a predetermined frequency.

23. A flowmeter according to any one of claims 15-22, comprising detection cancellation means for automatically starting measurement after a predetermined time period when a signal of the variation detection means is not detected.

24. A flowmeter according to any one of claims 15-23, wherein the transmission/reception means and the first and second vibration means include piezoelectric transducers.

25. A flowmeter, comprising: transmission/reception means provided in a flow path for performing transmission/reception using a state change of fluid; repetition means for repeating the transmission/reception; time measurement means for measuring a propagation time during repetition by the repetition means; flow rate detection means for detecting a flow rate based on a value of the time measurement means; variation detection means for detecting a fluid variation in a flow path; measurement control means for controlling each of the above means; and measurement monitoring means for monitoring abnormality in each of the above means.

26. A flowmeter according to claim 25, comprising a pair of transmission/reception means which utilize propagation of an ultrasonic wave as the state change of fluid.

27. A flowmeter according to claim 25, comprising transmission/reception means which utilizes propagation of

heat as the state change of fluid.

28. A flowmeter according to claim 26, comprising: a pair of transmission/reception means provided in a flow path for transmitting/receiving a sonic wave; repetition means for repeating signal propagation of the transmission/reception means; time measurement means for measuring a propagation time of a sonic wave during the repetition by the repetition means; flow rate detection means for detecting the flow rate based on a value of the time measurement means; variation detection means for detecting a fluid variation in a flow path; measurement control means for controlling each of the above means; and measurement monitoring means for monitoring abnormality in a start signal which directs start of transmission of a sonic wave at a first output signal of the variation detection means after a measurement direction signal of the measurement control means, and abnormality in an end signal which directs end of repetition of the transmission/reception of the sonic wave at second output signal of the variation detection means.

29. A flowmeter according to claim 28, comprising measurement monitoring means for directing a start of transmission of a sonic wave after a predetermined time when a start signal is not generated within a predetermined time period after a direction of the measurement control means.

30. A flowmeter according to claim 29, comprising measurement monitoring means for directing start of transmission of a sonic wave after a predetermined time when a start signal is not generated within a predetermined time period after a direction of the measurement control means, and for performing measurement a predetermined number of

repetition times.

31. A flowmeter according to claim 28, comprising measurement monitoring means which does not perform measurement until a next direction of the measurement control means when a start signal is not generated within a predetermined time period after a direction of the measurement control means.

32. A flowmeter according to claim 28, comprising measurement monitoring means which terminates reception of a sonic wave when an end signal is not generated within a predetermined time after a start signal.

33. A flowmeter according to one of claims 28 and 32, comprising measurement monitoring means which terminates reception of a sonic wave and outputs a start signal again, when an end signal is not generated within a predetermined time after a start signal.

34. A flowmeter according to claim 28, comprising measurement monitoring means for stopping transmission/reception processing when abnormality occurs in the number of repetition times.

35. A flowmeter according to claim 28, comprising measurement monitoring means which compares a first number of repetition times for measurement where a sonic wave is transmitted from a first one of the pair of transmission/reception means and received by the second transmission/reception means and a second number of repetition times for measurement where a sonic wave is transmitted from the second transmission/reception means

and received by the first transmission/reception means, and again outputs a start signal when the difference between the first and second numbers of repetition times is equal to or greater than a predetermined number of times.

36. A flowmeter according to claim 28, comprising repetition means for setting the number of repetition times such that a first number of repetition times for measurement where a sonic wave is transmitted from first one of the pair of transmission/reception means and received by the second transmission/reception means is equal to a second number of repetition times for measurement where a sonic wave is transmitted from the second transmission/reception means and received by the first transmission/reception means.

37. A flowmeter according to claim 28, comprising measurement monitoring means for monitoring the number of times that a start signal is output again so as to be limited to a predetermined number of times or less, such that the outputting of the start signal is not permanently repeated.

38. A flowmeter according to any one of claims 28-37, wherein the flowmeter measures a flow rate from a difference between inverse numbers of propagation times measured while repeating transmission/reception of an ultrasonic wave a plurality of number of times.

39. A flowmeter, comprising: instantaneous flow rate detection means for detecting an instantaneous flow rate; fluctuation determination means for determining whether or not there is a pulse in a flow rate value; and at least one or more stable flow rate calculation means for calculating a flow rate value using different means according to a

determination result of the fluctuation determination means.

40. A flowmeter, comprising: instantaneous flow rate detection means for detecting an instantaneous flow rate; filter processing means for performing digital-filter processing of a flow rate value; and stable flow rate calculation means for calculating a flow rate value using the filter processing means.

41. A flowmeter according to any one of claims 39 and 40, comprising stable flow rate calculation means for calculating a stable flow rate value using the digital filter processing means when the fluctuation determination means determines that there is a pulse.

42. A flowmeter according to any one of claims 38-41, wherein the fluctuation determination means determines whether or not a variation amplitude of a flow rate value is equal to or greater than a predetermined value.

43. A flowmeter according to any one of claims 39-42, wherein the filter processing means modifies a filter characteristic according to a variation amplitude of a flow rate value.

44. A flowmeter according to any one of claims 39-43, wherein the filter processing is performed only when a flow rate value detected by the instantaneous flow rate detection means is low.

45. A flowmeter according to any one of claims 39-44, wherein filter processing means modifies a filter

characteristic according to a flow rate value.

46. A flowmeter according to any one of claims 39-45, wherein filter processing means modifies a filter characteristic according to an interval of a measurement time of the instantaneous flow rate detection means.

47. A flowmeter according to claim 46, comprising filter processing means which modifies a filter characteristic such that a cut-off frequency of the filter characteristic becomes high when the flow rate is high, and which modifies a filter characteristic such that the filter characteristic has a low cut-off frequency when the flow rate is low.

48. A flowmeter according to any one of claims 39-47, wherein a filter characteristic is modified such that a variation amplitude of a flow rate value calculated by the stable flow rate calculation means is within a predetermined value range.

49. A flowmeter according to any one of claims 38-48, wherein an ultrasonic wave flowmeter which detects a flow rate by using an ultrasonic wave is used as the instantaneous flow rate detection means.

50. A flowmeter according to any one of claims 38-48, wherein a heat-based flowmeter is used as the instantaneous flow rate detection means.

51. A flowmeter, comprising: a flow rate measurement section through which fluid to be measured flows; a pair of ultrasonic wave transducers provided in the flow rate measurement section for transmitting/receiving an

ultrasonic wave; a driver circuit for driving one of the ultrasonic wave transducers; a reception detecting circuit connected to the other ultrasonic wave transducer for detecting an ultrasonic wave pulse; a timer for measuring a propagation time of the ultrasonic wave pulse; a control section for controlling the driver circuit; a calculation section for calculating a flow rate from an output of the timer; and periodicity change means for sequentially changing a driving method of the driver circuit, wherein the control section controls the periodicity change means such that the frequency of flow rate measurement is sequentially changed.

52. A flowmeter, comprising: a flow rate measurement section through which fluid to be measured flows; a pair of ultrasonic wave transducers provided in the flow rate measurement section for transmitting/receiving an ultrasonic wave; a driver circuit for driving one of the ultrasonic wave transducers; a reception detecting circuit connected to the other ultrasonic wave transducer for detecting an ultrasonic wave pulse; a control section for controlling the driver circuit for a predetermined number of times so as to drive the ultrasonic wave transducers again in response to an output of the reception detecting circuit; a timer for measuring an elapsed time for the predetermined number of times; a calculation section for calculating a flow rate from an output of the timer; and periodicity change means for sequentially changing a driving method of the driver circuit, wherein, in response to receipt of an output of the reception detecting circuit, the control section changes the periodicity change means at every receipt detection of the reception detecting circuit.

53. A flowmeter according to claims 51 and 52, wherein: the periodicity change means switchingly outputs a plurality of output signals having different frequencies; and the control section changes a frequency setting of the periodicity change means at every measurement so as to change a driving frequency of the driver circuit.

54. A flowmeter according to claims 51 and 52, wherein: the periodicity change means outputs output signals having the same frequency and a plurality of different phases; and the control section operates such that a phase setting for the output signal of the periodicity change means is changed at every measurement and a driving phase of the driver circuit is changed.

55. A flowmeter according to claims 51 and 52, wherein: the periodicity change means outputs a synthesized signal obtained by superposing a signal of a first frequency which is an operation frequency of the ultrasonic wave transducers and a signal of a second frequency which is different from the first frequency; and the control section outputs, through the driver circuit, at every measurement, an output signal where the second frequency of the periodicity change means is changed.

56. A flowmeter according to claim 55, wherein the periodicity change means changes the setting between a case where there is a second frequency and a case where there is not a second frequency.

57. A flowmeter according to claim 55, wherein the periodicity change means changes the phase setting of the second frequency.

58. A flowmeter according to claim 55, wherein the periodicity change means changes the frequency setting of the second frequency.

59. A flowmeter according to claim 52, wherein: the periodicity change means includes a delay section capable of setting different delay times; and the control section changes the setting of the delay at each transmission of an ultrasonic wave or at each receipt detection of an ultrasonic wave.

60. A flowmeter according to claims 51 and 52, wherein the cycle width changed by the periodicity change means is a multiple of a value corresponding to a variation of a propagation time which is caused by a measurement error.

61. A flowmeter according to claims 51 and 52, wherein the cycle width changed by the periodicity change means is equal to a cycle of a resonance frequency of the ultrasonic wave transducers.

62. A flowmeter according to claims 51 and 52, wherein the order of patterns for changing the periodicity is the same for both measurement in a upstream direction and measurement in a downstream direction.

63. A flowmeter according to claim 52, wherein the predetermined number of times is a multiple of a change number of the periodicity change means.

64. A flowmeter, comprising: a flow rate measurement section through which fluid to be measured flows; a pair of

ultrasonic wave transducers provided in the flow rate measurement section for transmitting/receiving an ultrasonic wave; a driver circuit for driving one of the ultrasonic wave transducers; a reception detecting circuit connected to the other ultrasonic wave transducer for detecting an ultrasonic wave pulse; a first timer for measuring a propagation time of the ultrasonic wave pulse; a second timer for measuring a time period from when the reception detecting circuit detects a receipt to when a value of the first timer changes; a control section for controlling the driver circuit; and a calculation section for calculating a flow rate from outputs of the first timer and second timer, wherein the second timer is corrected by the first timer.

65. A flowmeter according to claim 64, comprising a temperature sensor, wherein the second timer is corrected by the first timer when an output of the temperature sensor varies so as to be equal to or greater than a set value.

66. A flowmeter according to claim 64, comprising a voltage sensor, wherein the second timer is corrected by the first timer when an output of the voltage sensor varies so as to be equal to or greater than a set value.

67. A flowmeter, comprising: a flow rate measurement section through which fluid to be measured flows; a pair of ultrasonic wave transducers provided in the flow rate measurement section for transmitting/receiving an ultrasonic wave; a driver circuit for driving one of the ultrasonic wave transducers; a reception detecting circuit connected to the other ultrasonic wave transducer for detecting an ultrasonic wave pulse; a control section for

controlling the driver circuit for a predetermined number of times so as to drive the ultrasonic wave transducers again in response to an output of the reception detecting circuit; a timer for measuring an elapsed time for the predetermined number of times; a calculation section for calculating a flow rate from an output of the timer; and periodicity stabilizing means for sequentially changing a driving method of the driver circuit, wherein the control section controls the periodicity stabilizing means such that a measurement frequency is always maintained to be constant.

68. A flowmeter according to claim 67, wherein: the control section includes periodicity stabilizing means formed by a delay section capable of setting different delay times; and the control section changes an output timing of the driver circuit by switching the delay times.

69. A flowmeter according to claim 67, wherein the control section controls the driver circuit such that a measurement time is maintained to be constant.